

A Digital VLSI Design of a 16 Bit Dynamic Funnel Shifter

By Pablo Martinez



What is a Funnel Shifter ?

- Perform 6 different operations
 - Logic Shift Right
 - Logic Shift Left
 - Arithmetic Shift Right
 - Arithmetic Shift Left
 - Barrel Shift Right
 - Barrel Shift Left

Operations of Funnel Shifter

- Logic Shifter – After shift fills vacated positions with 0's.

ex. Logic Shift Right 2

110110 → __1101 → 001101

ex. Logic Shift Left 2

110110 → 0110__ → 011000

Ops. of A Funnel Shifter (cont)

- Arithmetic shifter

- For Right shift fills vacated positions with a value of Most Significant Bit

ex. Arithmetic Shift Right 2

110110 → __1101 → 111101

- For Left shift, same as Logic Shifter

Ops. of A Funnel Shifter (cont)

- Barrel shifter - Pushed out bits fill vacated bit positions.

ex. Barrel Shift Right 2

110110 → __1101 → 101101

ex. Barrel Shift Left 2

110110 → 0110__ → 011011

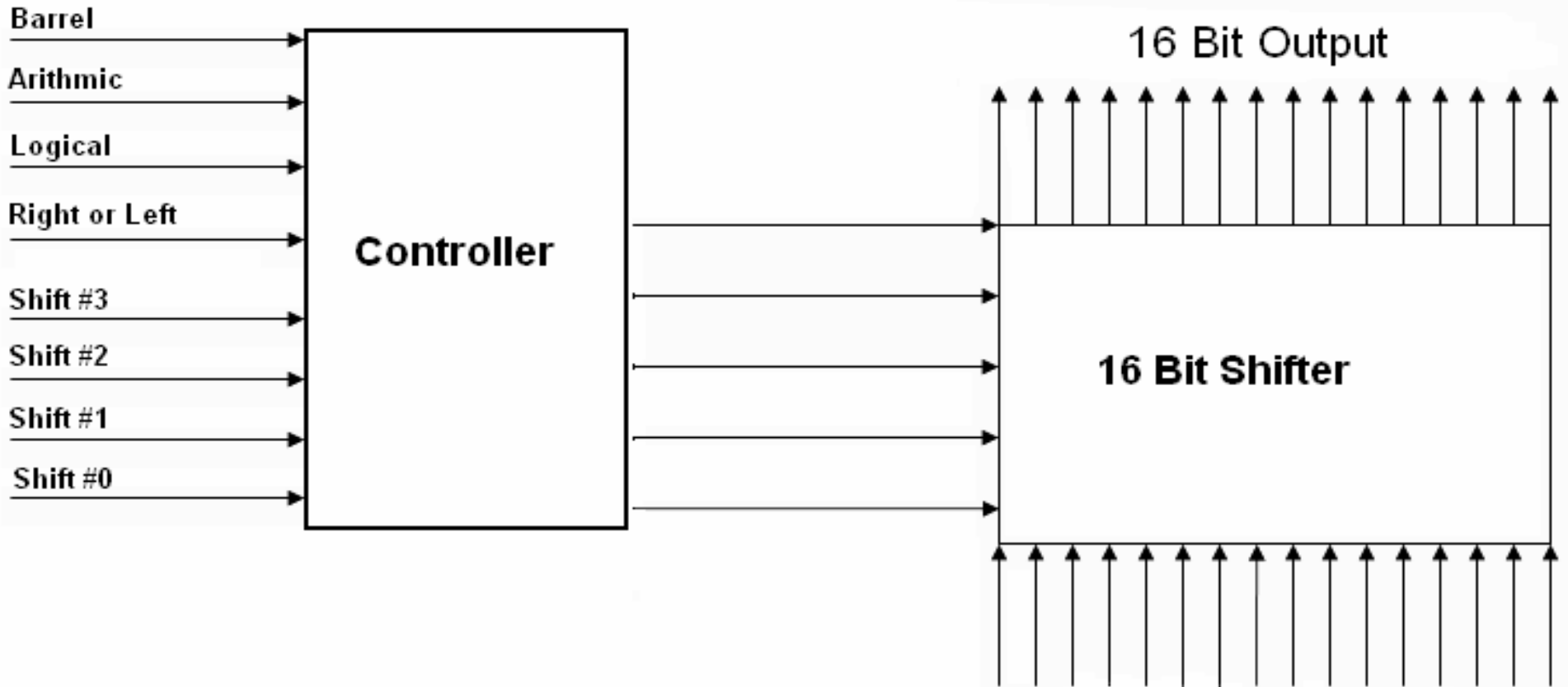
Relations Between the Functions

- Logic Shift Left = Arithmetic Shift Left
- Barrel Shift Right = $N_t - \text{Barrel Shift left}$;
where N_t = Total number of Bits

ex. For a 4 Bit shifter

 $4 - \text{Barrel Shift Left } 1 = \text{Barrel Shift Right } 3$
- Logic Shift Right = $N_t - \text{Logic Shift left}$;
where N_t = Total number of Bits

Overview of project



2 Major Components of Design

Controller

Shifter

16 Bit Input

16 Bit Output

Why Dynamic ?

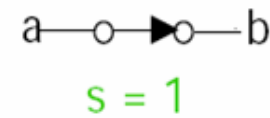
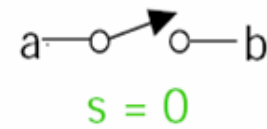
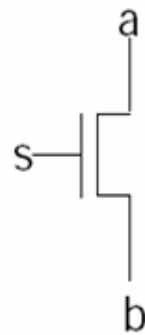
- The Dynamic design allows data to be Manipulated at a Faster Frequency.
- Dynamic design consists of a pre-charge and evaluate.

IDEAL CHARACTERISTICS

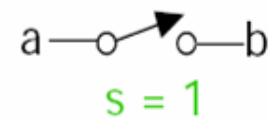
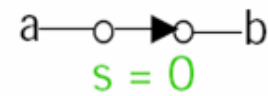
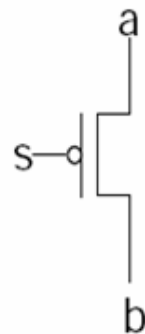
SYMBOLS

SWITCH CHARACTERISTICS

N- SWITCH

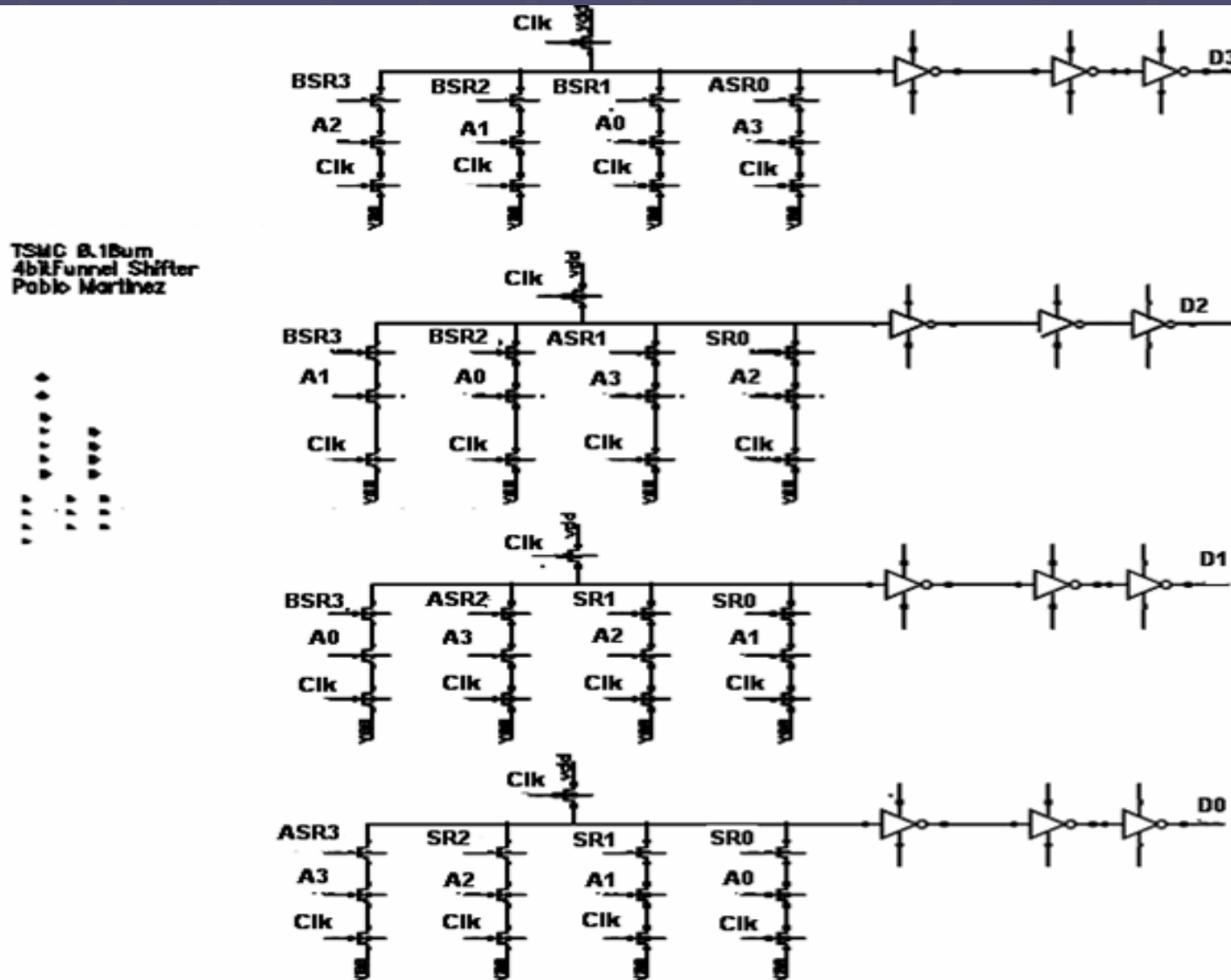


P- SWITCH

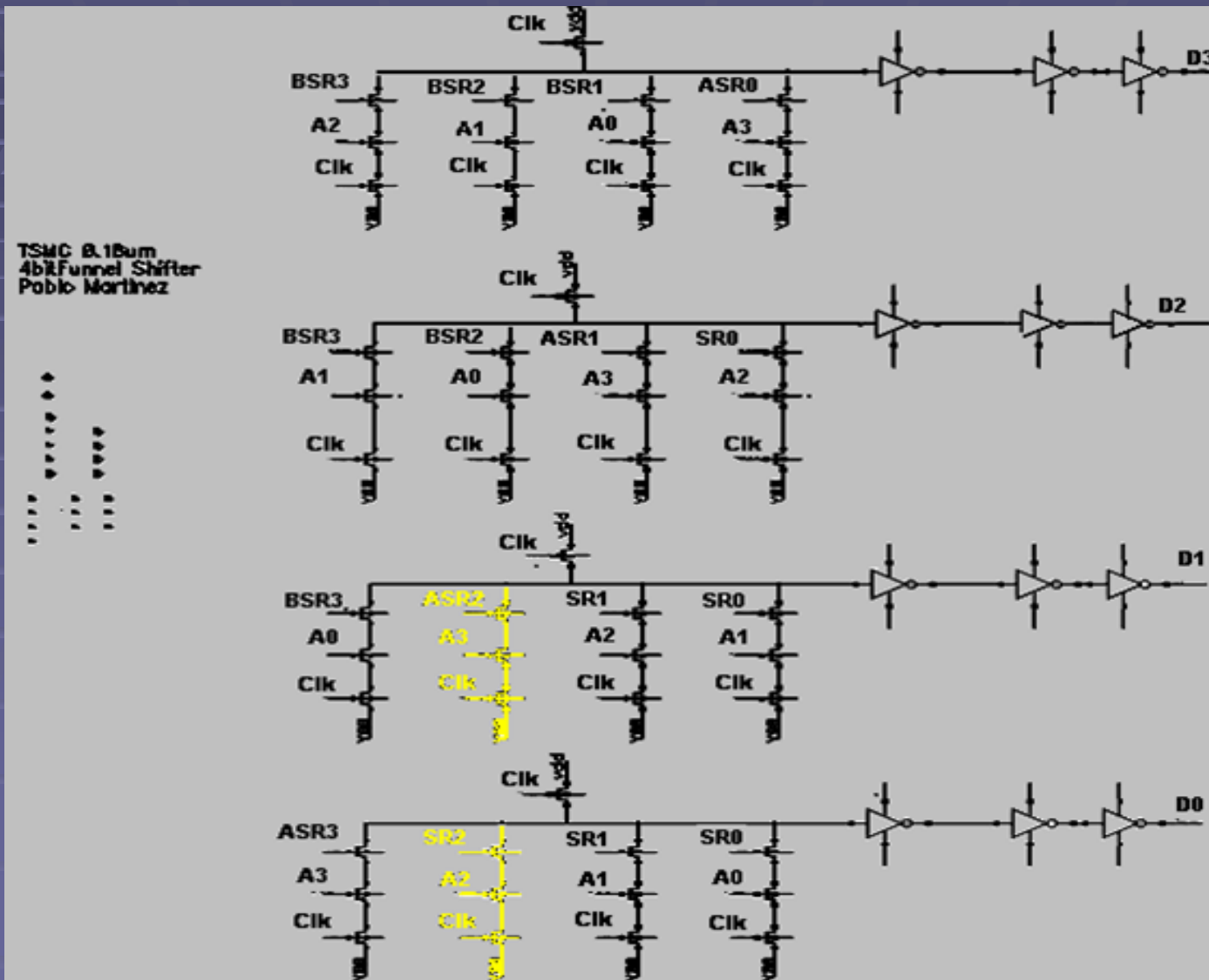


Dynamic 4 – Bit Funnel Shifter

TSMC 0.18um
4bit Funnel Shifter
Pablo Martinez



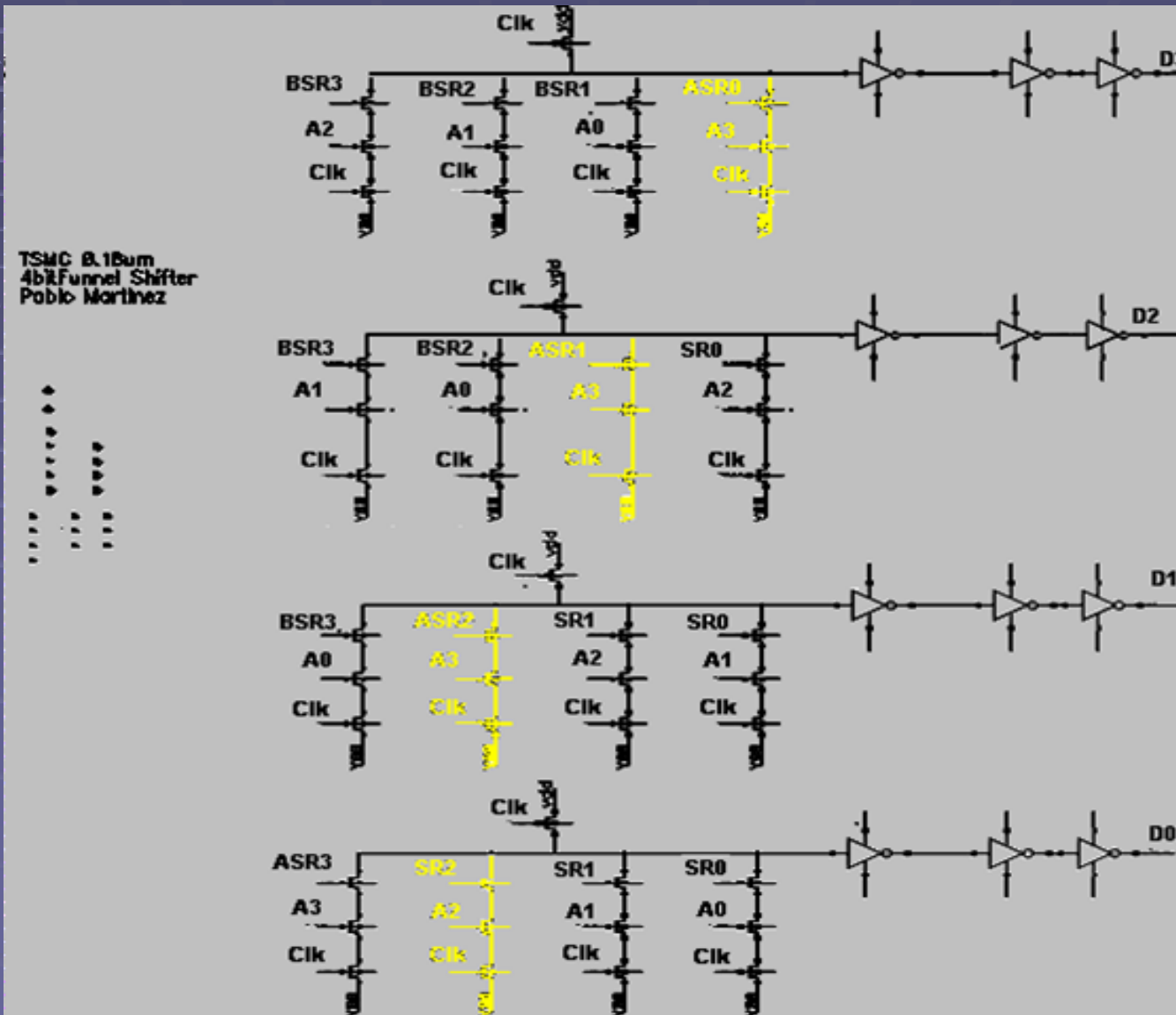
Functionality of Logic Shift Right 2



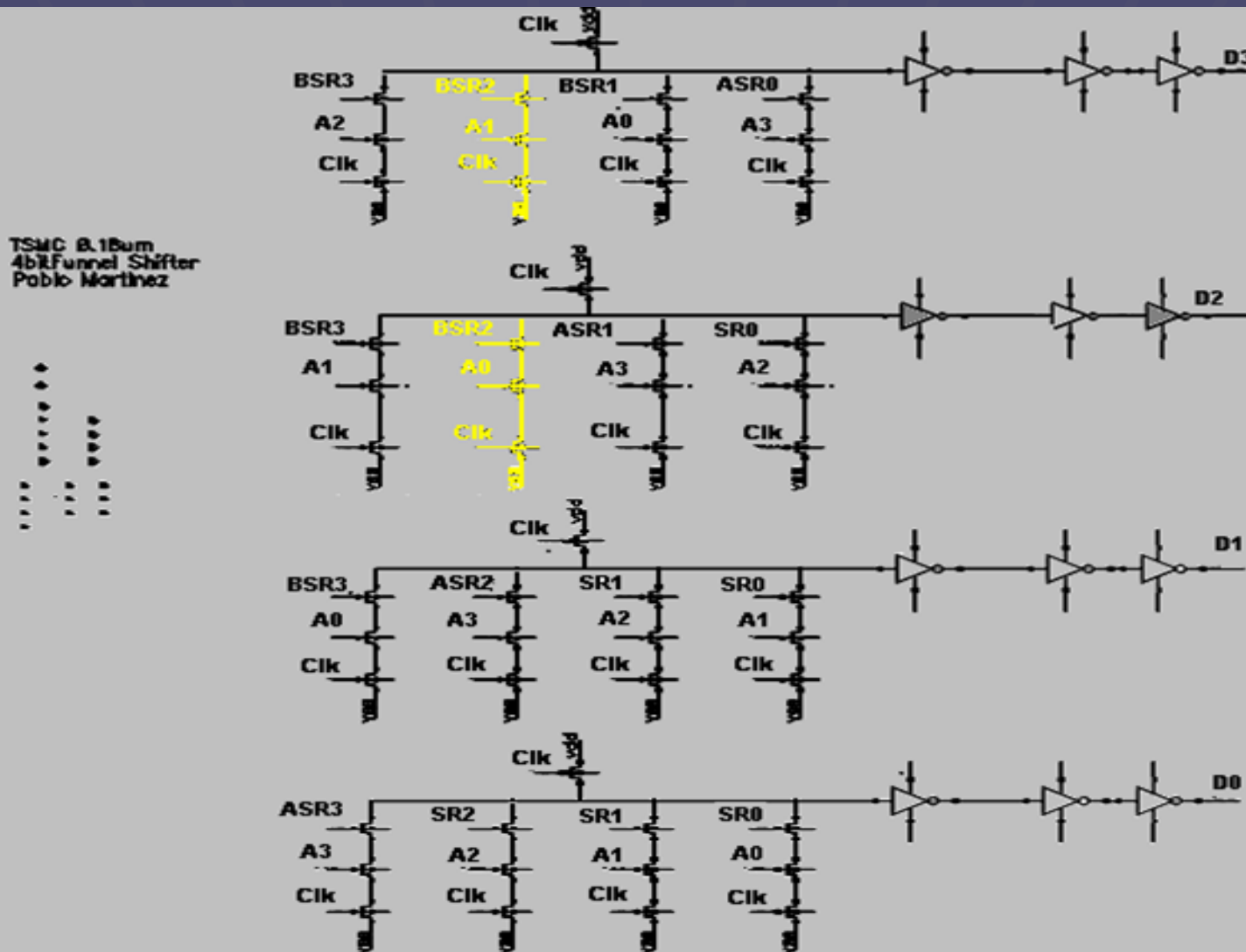
Functionality of Barrel Shift Right 2



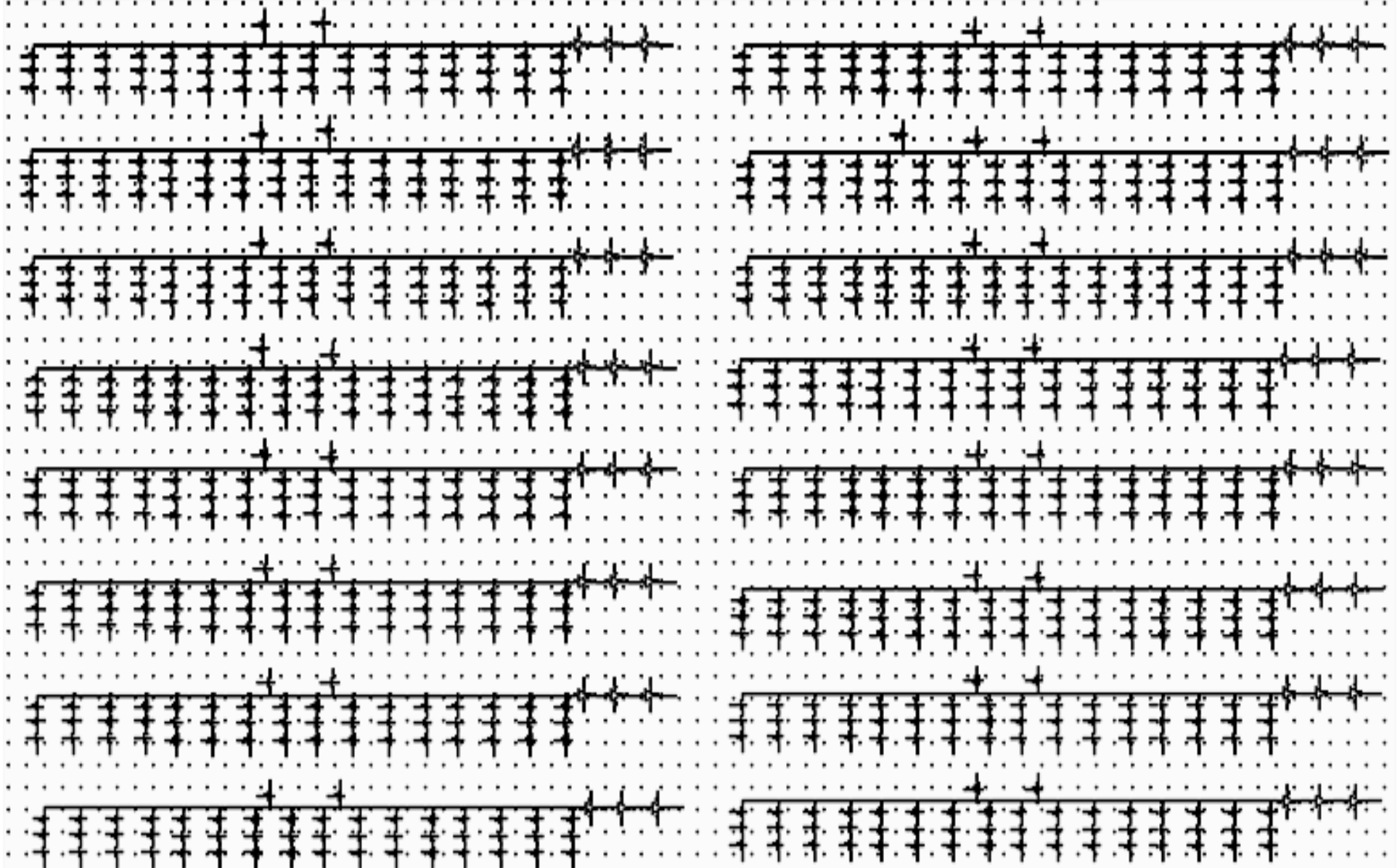
Function of Arithmetic Shift Right 2



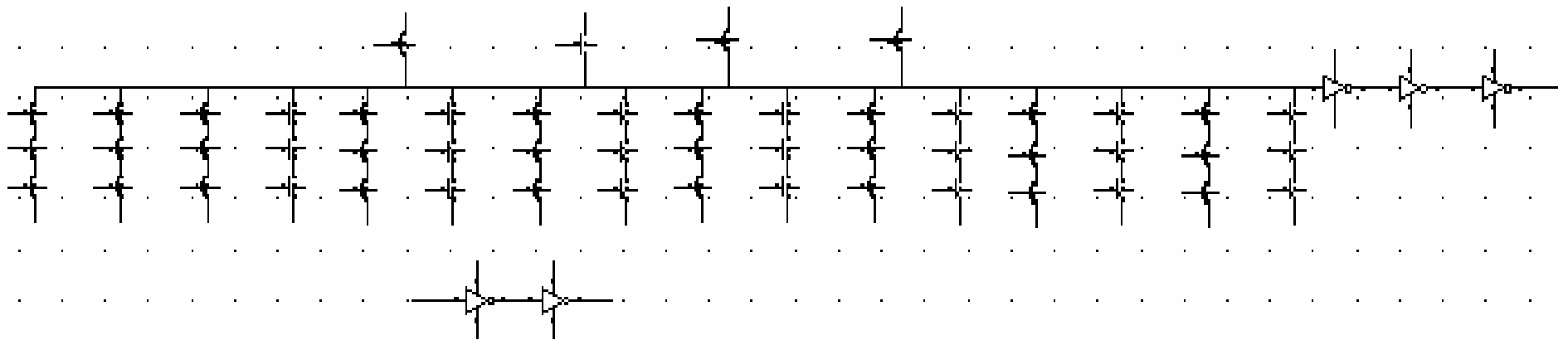
Functionality of Logic Shift Left 2



16 Bit Funnel Shifter



Funnel Shifter Sub-circuit



Controller Design

- In order to develop the an efficient design
 - Truth tables
 - Boolean expressions

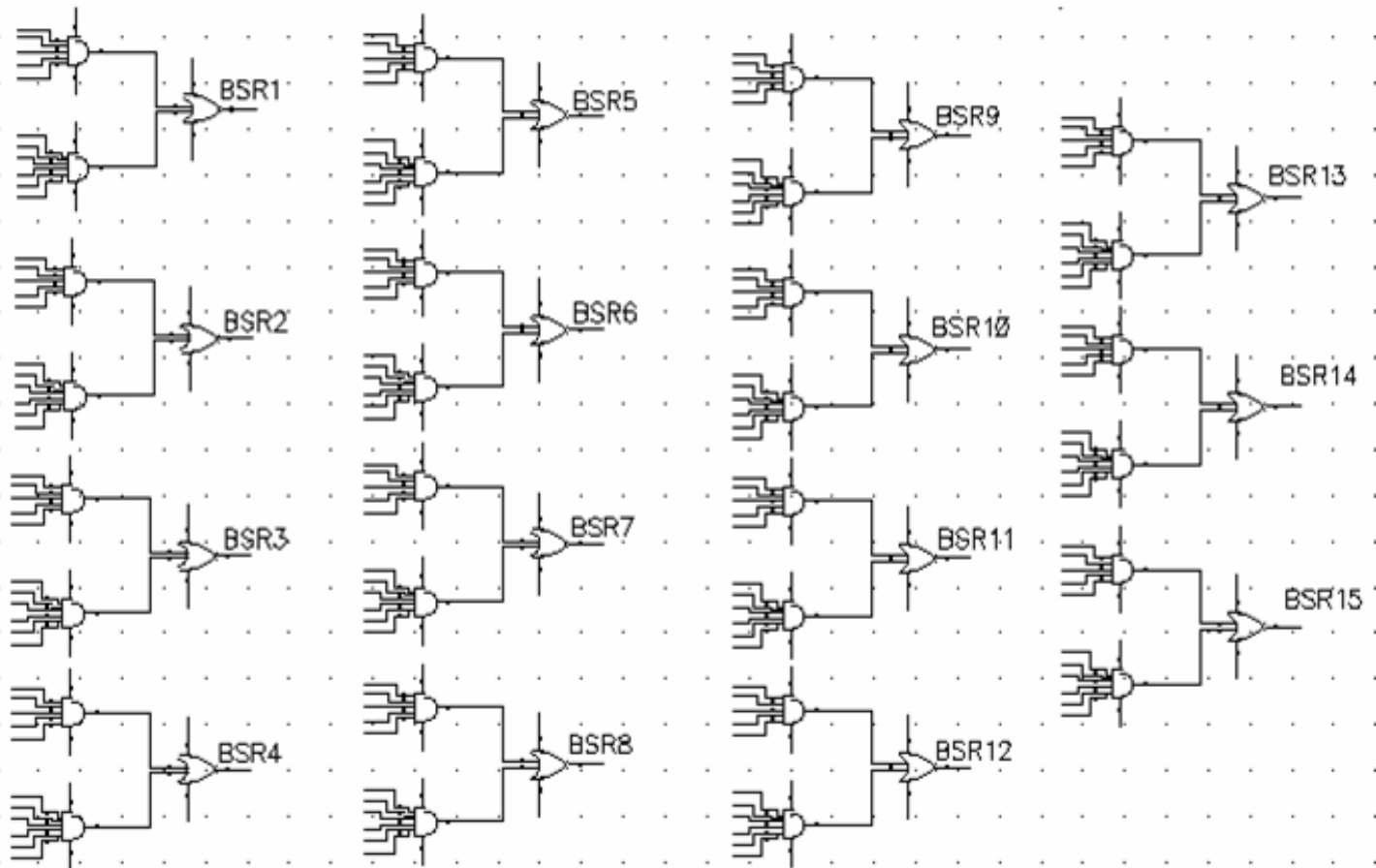
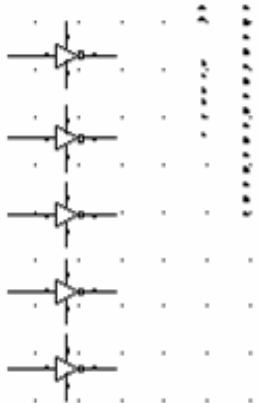
4- Bit Funnel Truth Table

Arithmetic	Barrel	Logic	R/L	Shift#1	Shift#0	SR0	SR1	SR2	AR0	AR1	AR2	AR3	BR1	BR2	BR3
0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0
0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0
0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0
0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0
0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0
0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1
0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0
0	0	1	1	1	1	0	0	0	0	0	0	0	1	0	0
0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0
0	1	1	0	0	1	0	1	0	0	1	0	0	1	0	0
0	1	1	0	1	0	0	0	1	0	0	1	0	0	1	0
0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0
0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0
0	1	1	1	0	1	0	0	1	0	0	0	1	0	0	0
0	1	1	1	1	0	0	1	0	0	1	0	0	0	1	0
0	1	1	1	1	1	1	0	0	0	1	0	0	1	0	0
1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
1	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0
1	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0
1	0	0	0	1	1	0	0	0	1	1	1	1	0	0	0
1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0
1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1
1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0

Barrel Shift Logic

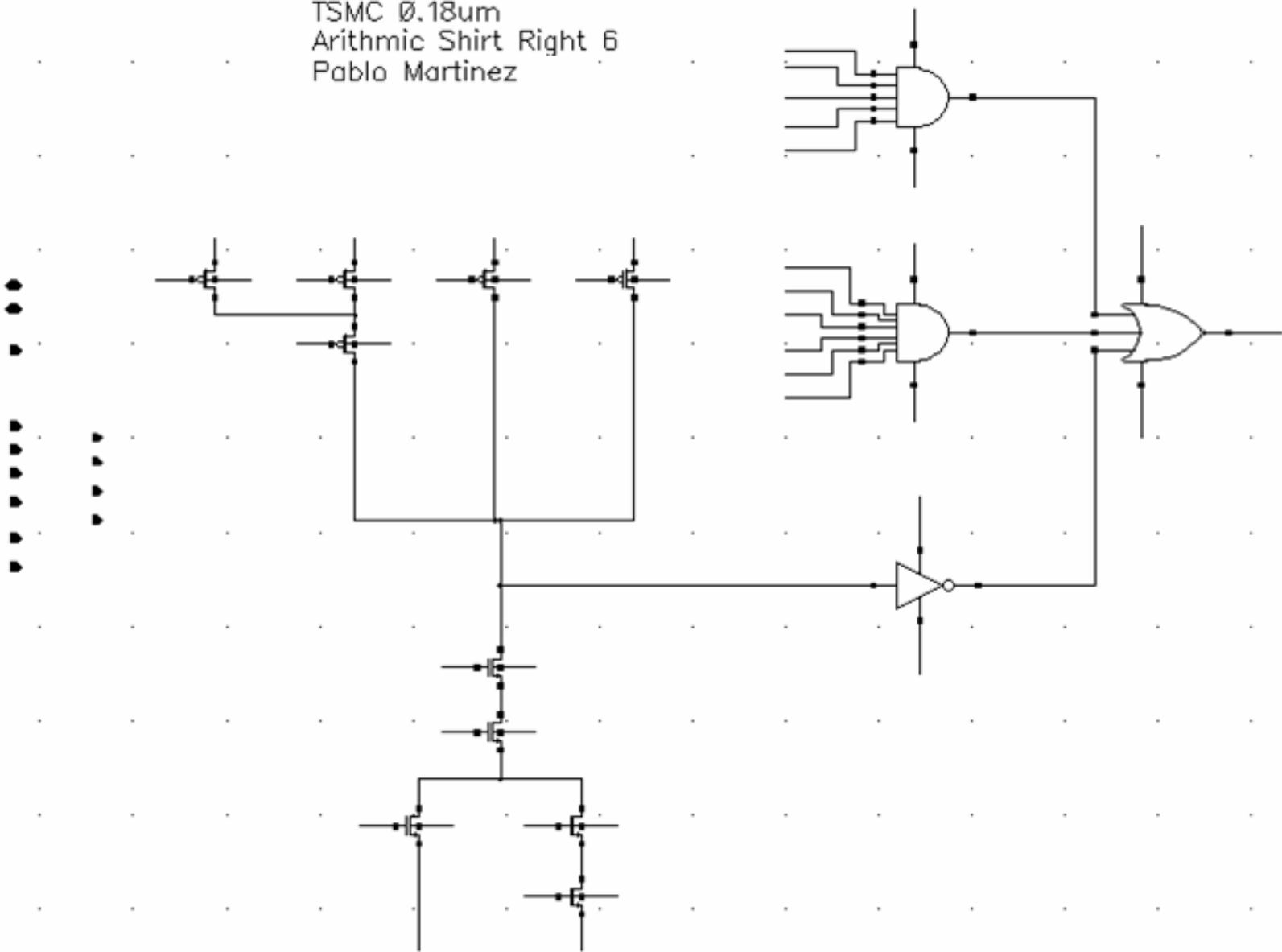
TSMC 0.18um
16 Bit Barrel Funnel Controller
Pablo Martínez

Barrel Right Controllers



Arithmetic Shift 6

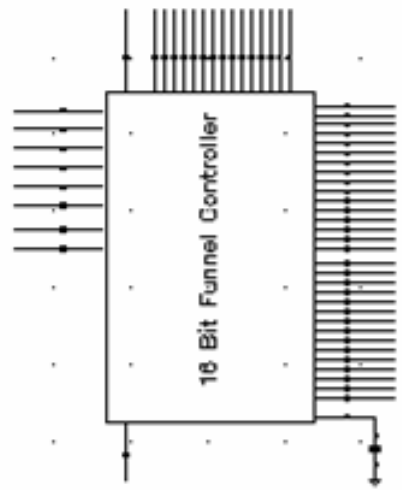
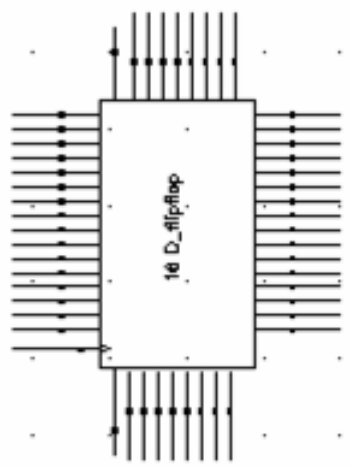
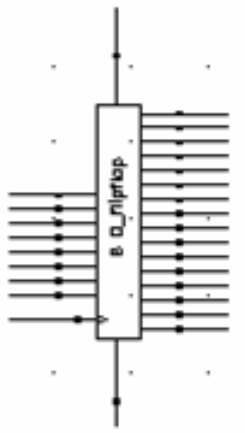
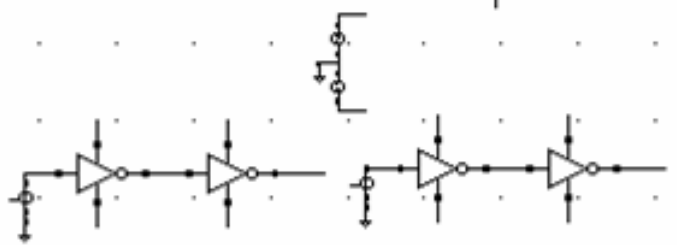
TSMC 0.18um
Arithmetic Shift Right 6
Pablo Martinez



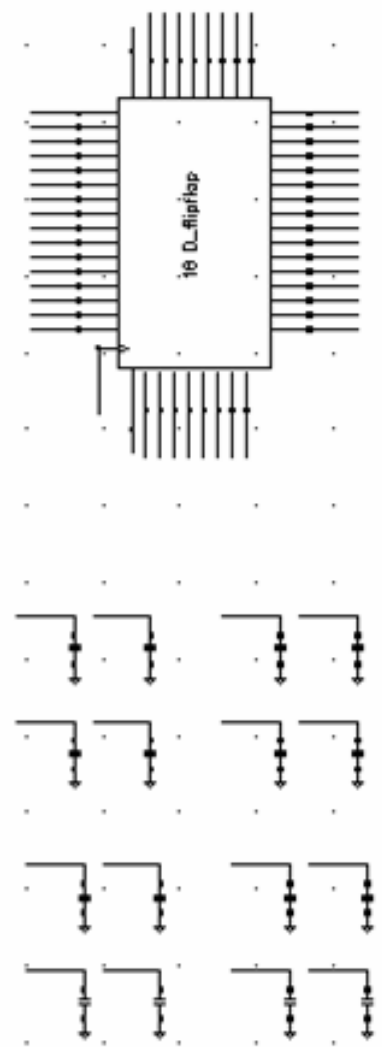
THE Final

PROJECT

Test Bench



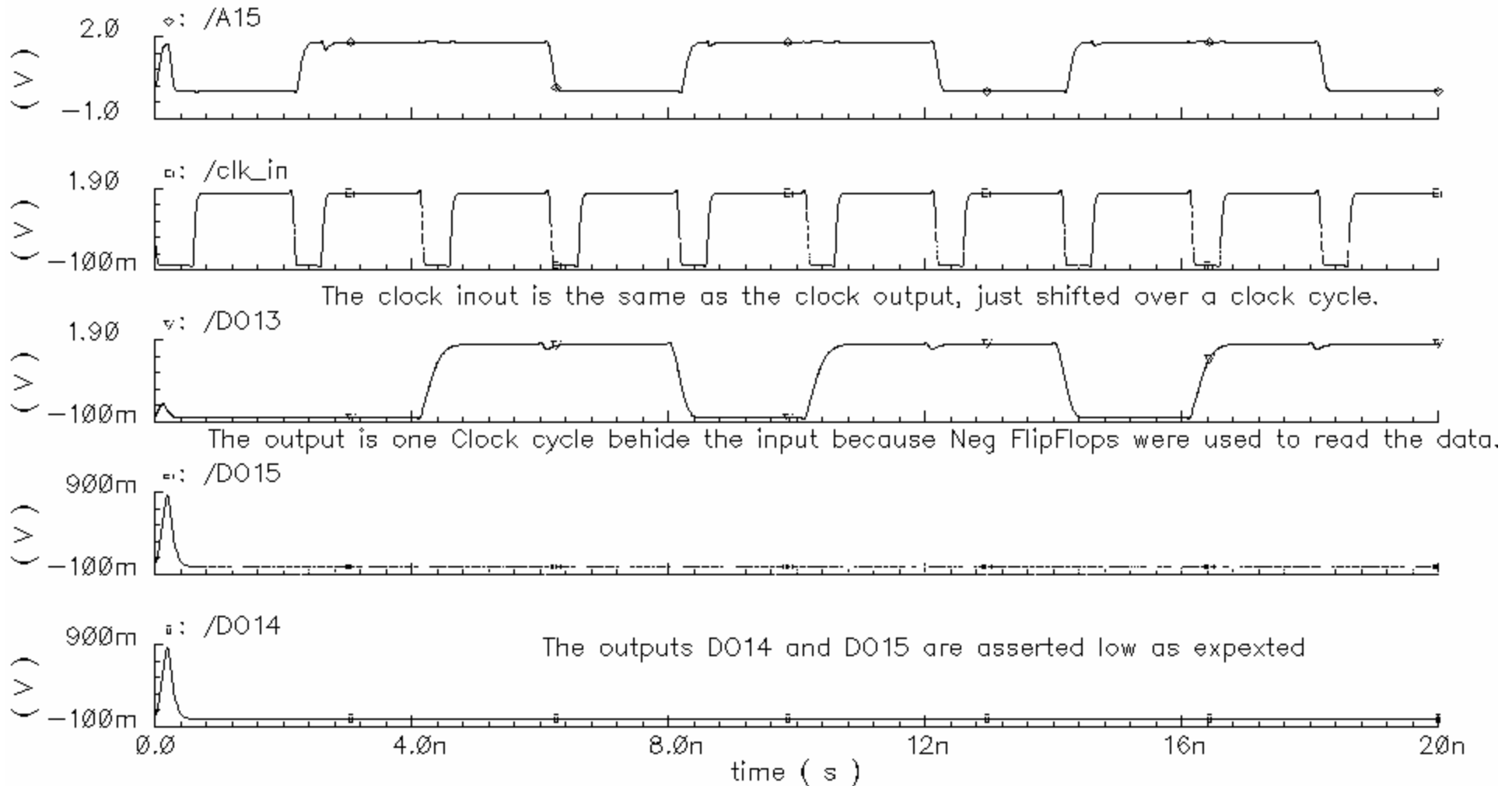
TSMC 0.18um
Project Test Bench
Pablo Martinez



Project Logic Shift Right 2

Wave form for Logic Shift Right 2

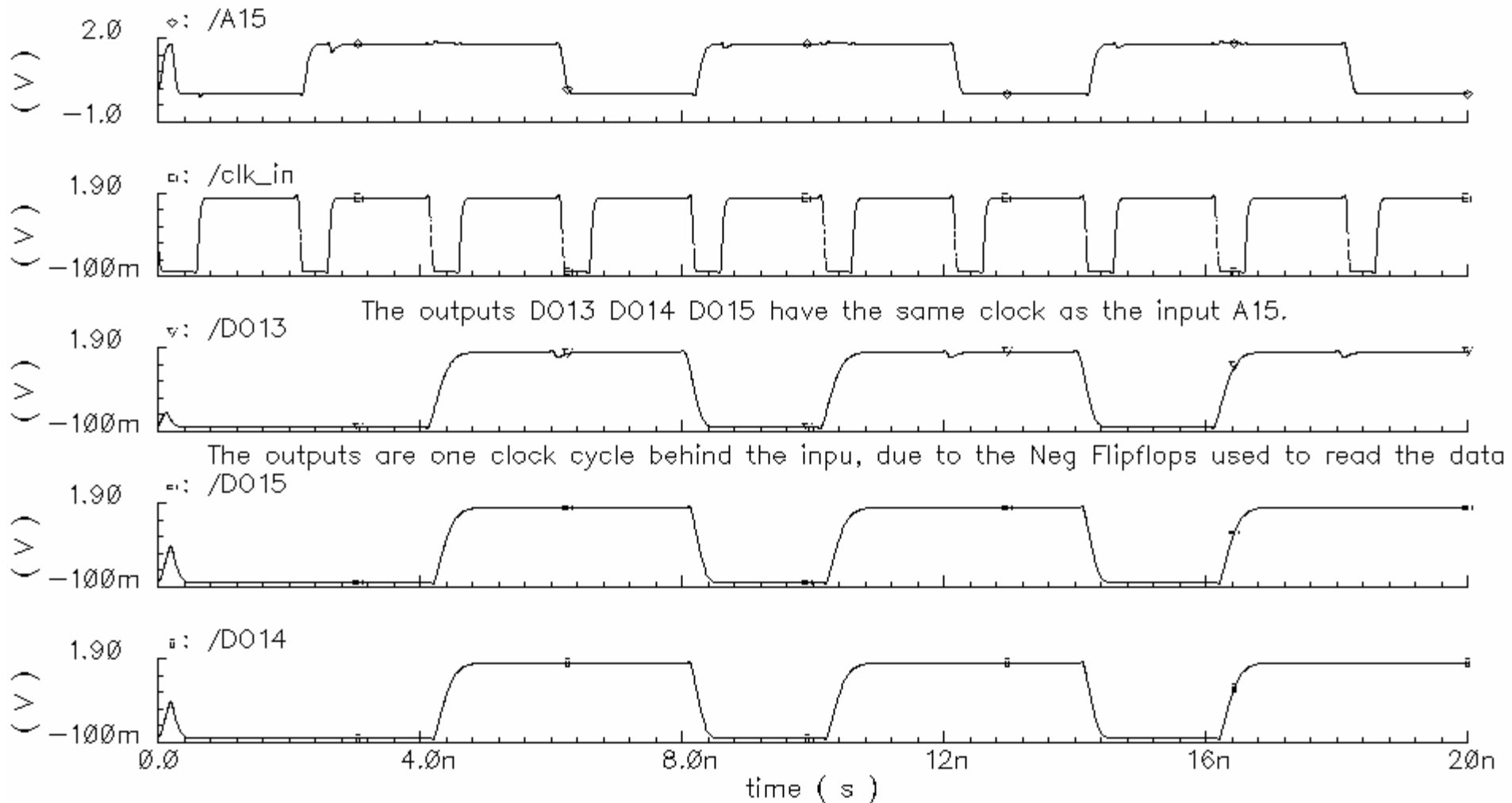
Transient Response



The Project, Arithmetic Shift Right 2

Project Arithmetic Shift Right 2

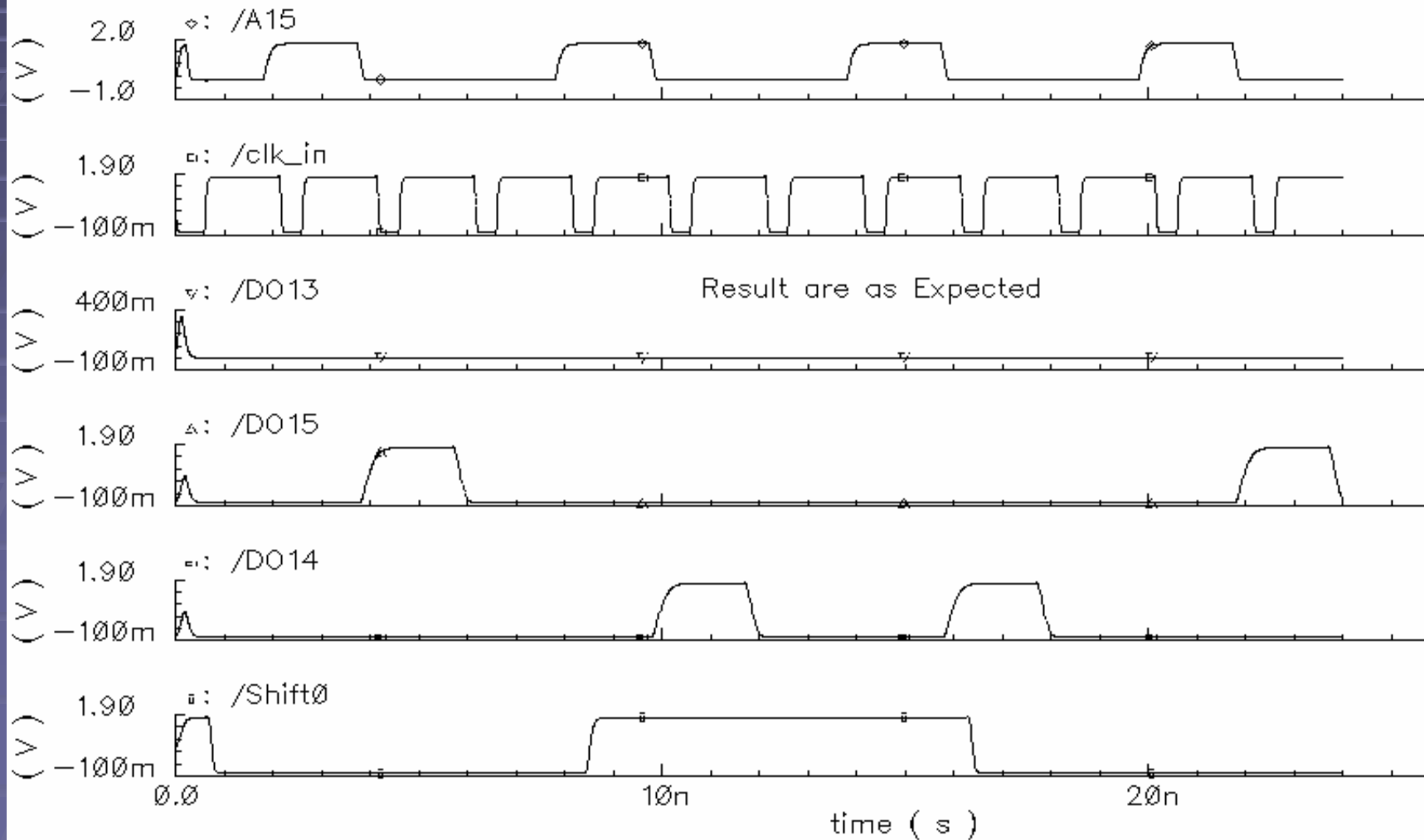
Transient Response



Function Switching LSR 0 to 1

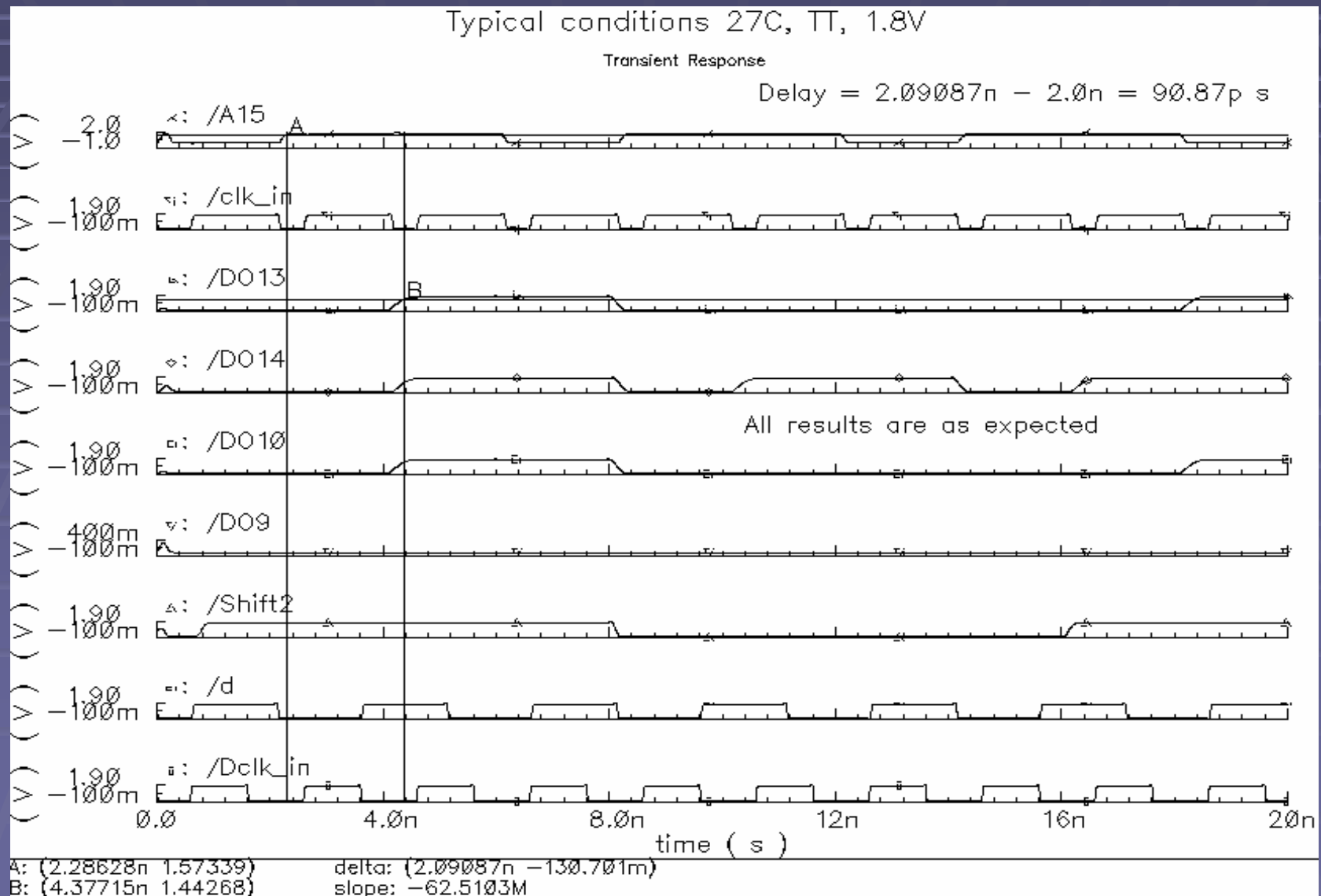
Switch from a Logic Shift Right 0 to a Logic shift 1

Transient Response

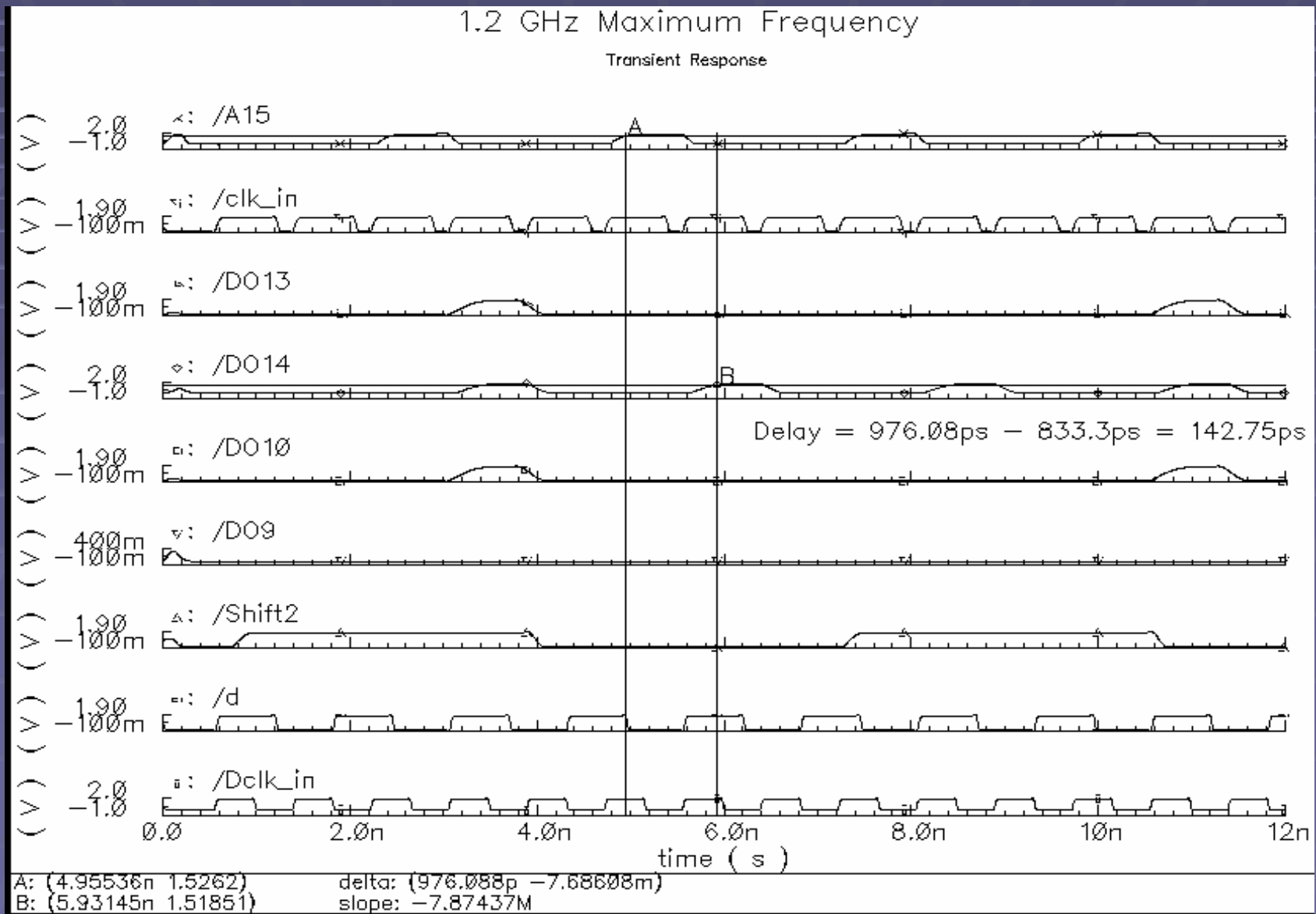


Switching functions which cause the greatest Delay

Arithmetic shift Right 5 to Arithmetic shift Right 1.

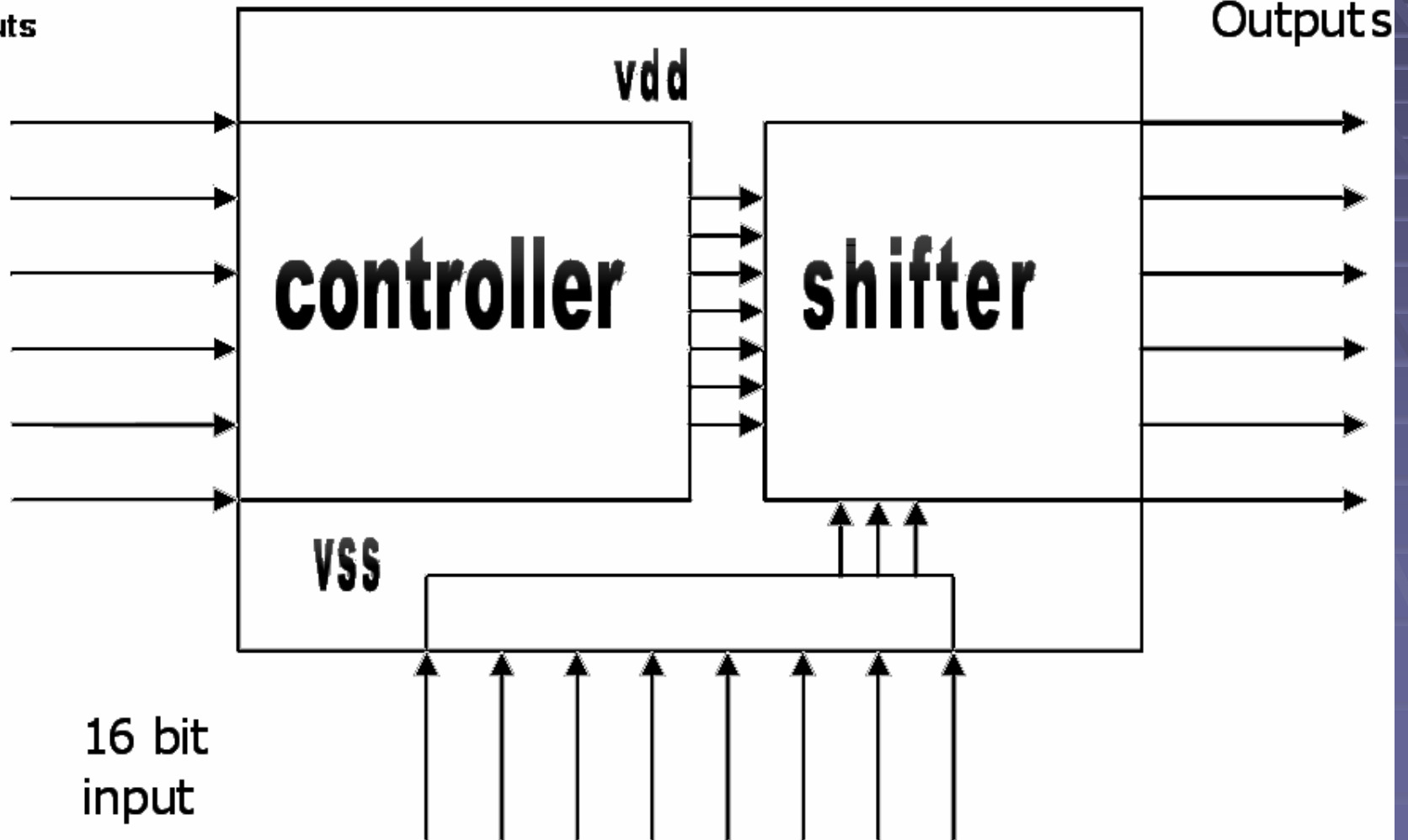


Maximum Frequency 1.2 GHz



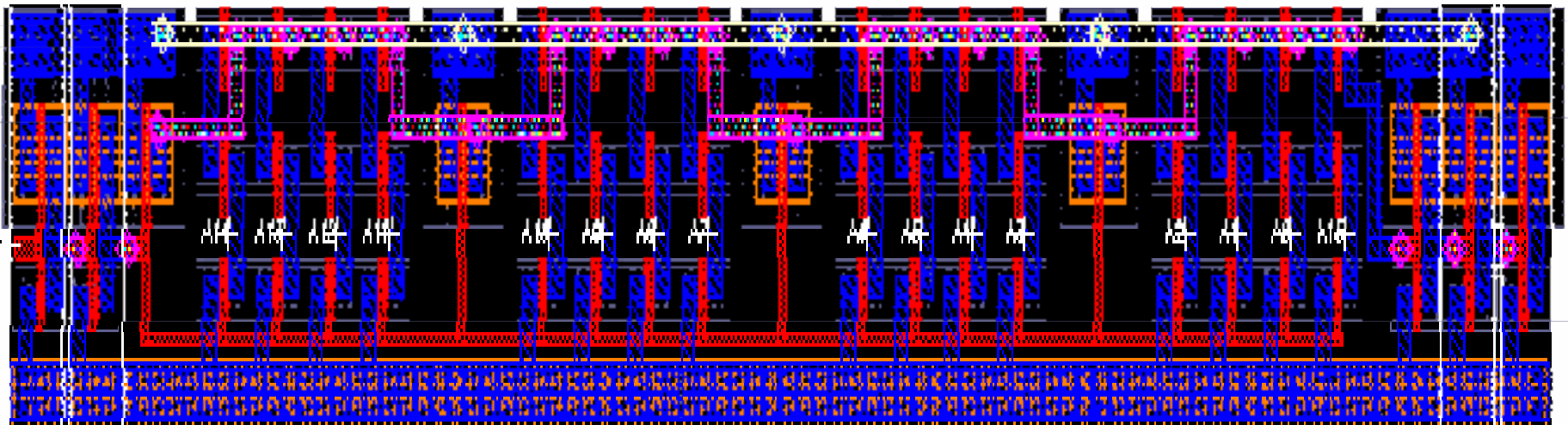
Layout Blueprint

Controller
Inputs



16 bit
input

Basic Building block of Funnel Shifter



Layout of 16 Bit Funnel Shifter

